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Fluvial knickpoint identification and their characterizations in the drainage basins of Western Ghats, India

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Abstract The fluvial knickzones, a geomorphic marker of erosion, climate, and tectonics has received much interest in the topographic developmental studies in the recent past. Nevertheless, examining their spatial distribution in passive margins has not been well documented especially for the drainage basins in the humid tropical climatic systems. Here in this study, we presented the spatial distribution of knickzones in the three river basins of Western Ghats, India, namely Chaliyar, Pambar and Muthirapuzha basins. Because the conventional method of knickzone identification using topographic maps or field readings is laborious, we employed a 30 m digital elevation model and TopoToolBox, a Matlab© based tool to extract the knickpoints in the study area. A total of 356 knickpoints were identified by analyzing ~ 2670 km of river network, and the knickzone frequency is estimated as 0.13 km^{-1}. The average height of the knickzones is found to be 83 m, and majority of the knickpoints are located closest to the headwaters. Although we noticed that the streams underlying metamorphic lithology tends to have the highest knickzone frequency, but it can be also attributed to the fact that metamorphic rocks are the most dominant rock type in the study area. The high amount of knickzone frequency in the study area thus may be the result of coupled climatic control caused by heavy summer rainfall, bed rock erosion triggered by high grade metamorphism, and also the local base level changes as indicated by the clustered knickpoints in the stream heads.

Keywords Knickzone · Remote sensing · TopoToolbox · Western ghats · Fluvial morphology

1 Introduction

Knickzones or knickpoints are defined as the part of the longitudinal profile of a river having an evident steeper slope than the adjacent sections of the river. Knickzones were also previously defined as the areas of a noticeable increase in the downstream stream gradient in a fluvial segment [1, 2]. They are typical of bedrock Rivers [3, 4], and the most natural shape of a knickzone is a waterfall. Factors that cause the formation of knickzones or those affecting them have been explained in several studies [1, 4–7]. The dominant controlling factors of knickzone origin are active tectonism [8–10], fall in the base level [11], changes in sediment load from tributaries [12], landslides [13], bedrock erosional resistance [14], and climate [7]. Studies in the Himalayas found a high correlation of knickpoints with the active thrust faults and landslide dams and hence, these are the major knickpoint triggering factors in the region [15, 16]. A few studies also proposed that a blend of all aforementioned factors can be responsible for knickzone formation [17–20].

Knickpoints are typically known as: (1) break-in-gradient or slope break knickzone, formed by a sharp change in

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